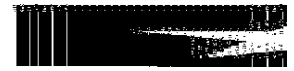
DMSO Data Engineering Program
July 17, 1996

Presented by
Jack Sheehan, DMSO Data Engineer
DoD Modeling and Simulation Functional Data Administrator(FDAd)
Email: jsheehan@msis.dmso.mil
Phone: 703-998-0660 x287



M&S Common Technical Framework

DMSO is developing data standards to support three key modeling and simulation products:

- **Conceptual Models of the Mission Space (CMMS),**
- **the High Level Architecture (HLA), and**
- **authoritative representations of environment, units and systems, and human behavior**

as directed in the DoD Modeling and Simulation Master Plan.

This presentation describes...

Data engineering to support CMMS, HLA, and authoritative representations:

- **the Data Engineering Technical Framework (DE TF)**
- **DMSO projects to demonstrate the DE TF**
- **DoD data standardization**

M&S Representations

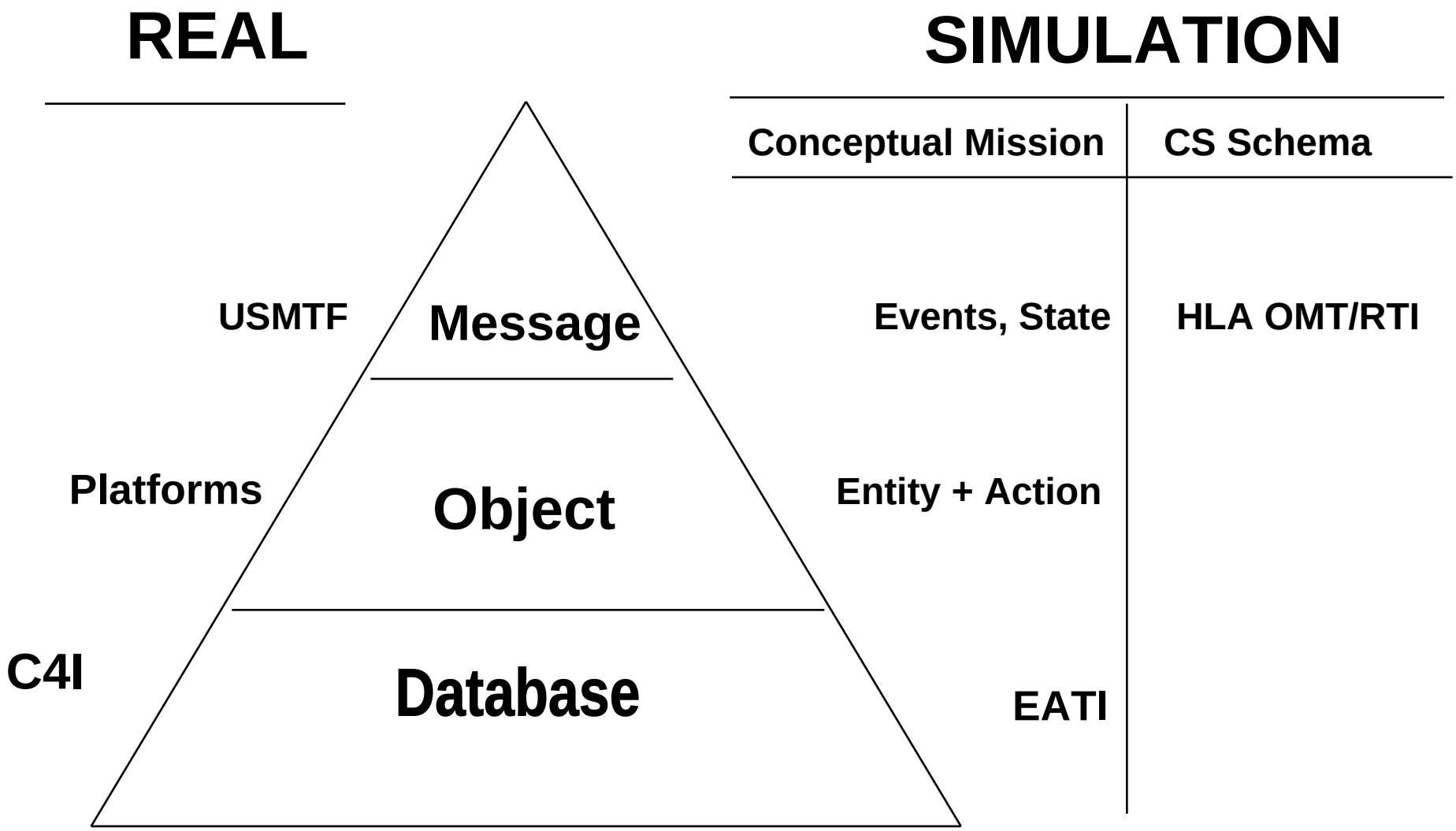
An M&S representation is the combination of a

- **Model, Process, or Algorithm and the associated**
- **Data, Parameters, or Values.**

The traditional implementation separates Algorithms and Values. Contemporary implementation joins Model and Data as an Object.

Whether in the traditional form of Algorthims distinct from Values or in the contemporary form of Objects, it's all DATA in the DMSO DE program.

Messages, Objects, Databases



Data Engineering Technical Framework

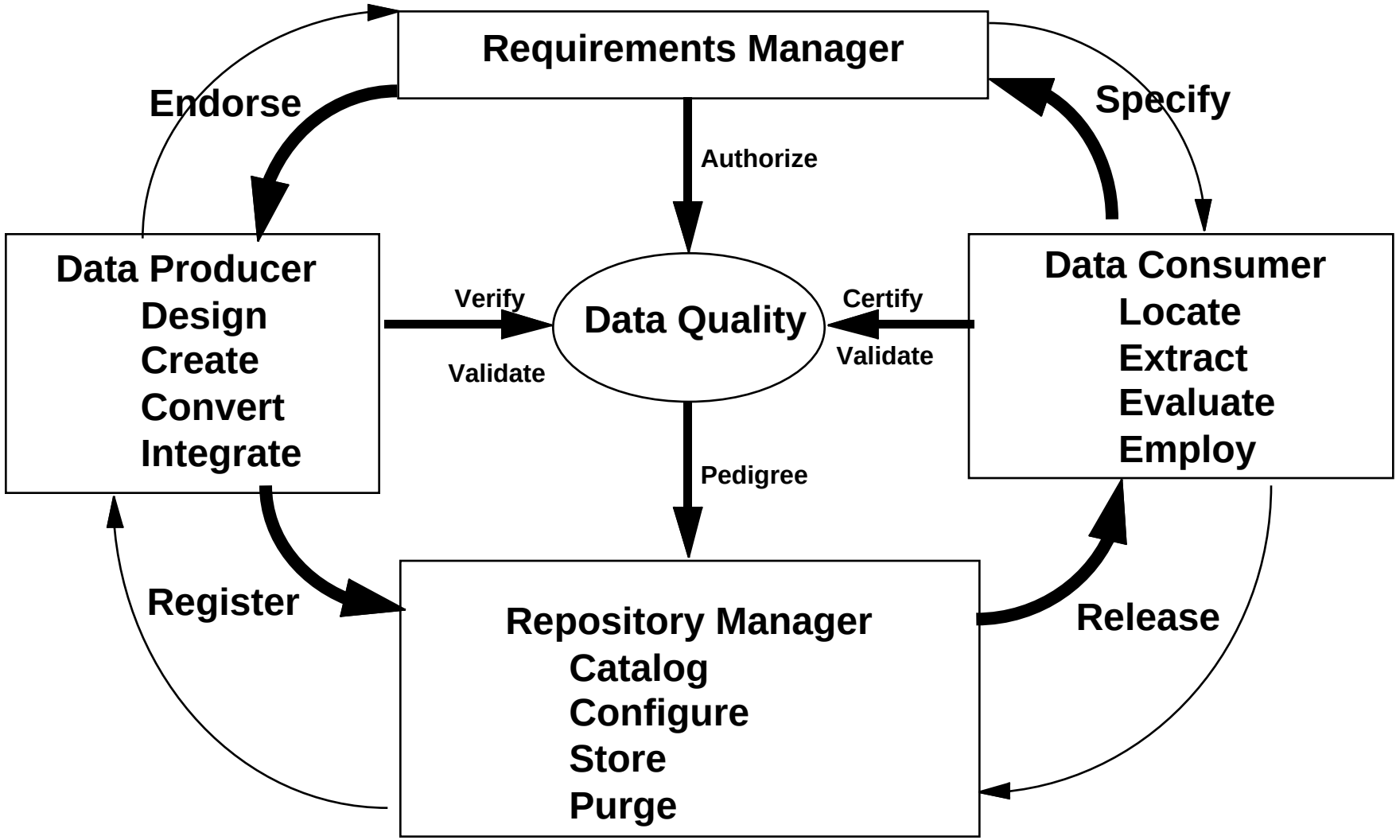
Rigorous procedure for providing simulation data to simulation developers and end users which are:

- **Derived from authoritative sources**
- **Described using common syntax and semantics**
- **Examined for data quality**
- **Released to authorized consumers**
- **Protected from unauthorized access or modification**

In particular, the DE Technical Framework will specify:

- **Data engineering process**
- **Data Interchange Formats (DIF)**
- **Authoritative Data Sources (ADS)**
- **Authorized Data Consumers (ADC)**
- **Data quality practices**
- **MSRR integration**

Data Engineering Process, Version 0.1.3



Supporting DE Products

Data Interchange Formats (DIF)

- **Content (semantics)**
- **Structure (syntax)**
- **Interfaces (tools & utilities)**

Authoritative Data Sources (ADS)

- **Producer Identification**
- **Data Interchange Format**

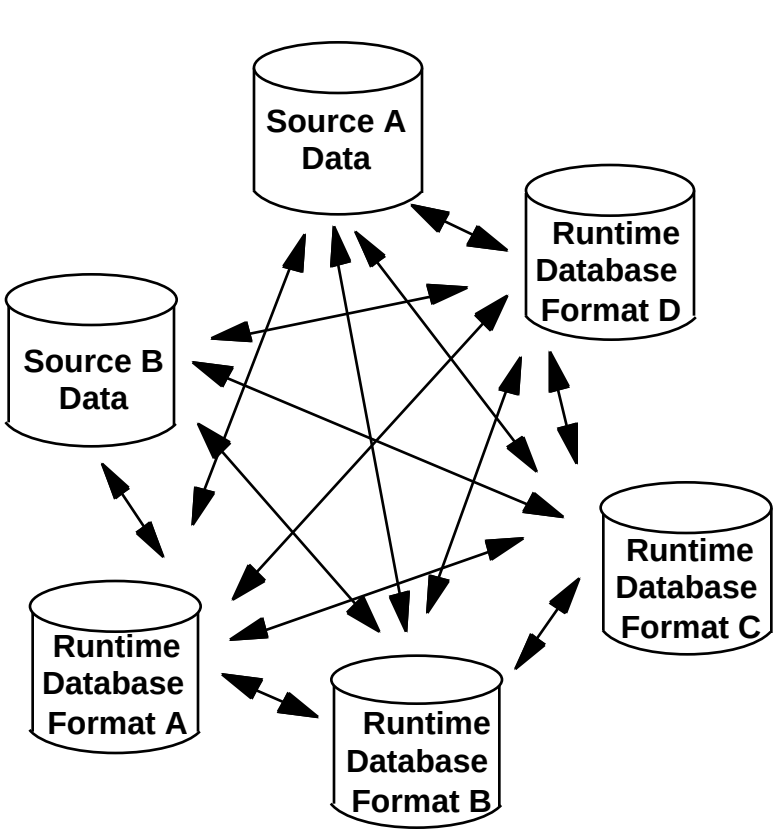
Authorized Data Consumers (ADC)

- **Consumer Identification**
- **Data Interchange Format**
- **ADS Protection/Releasability**

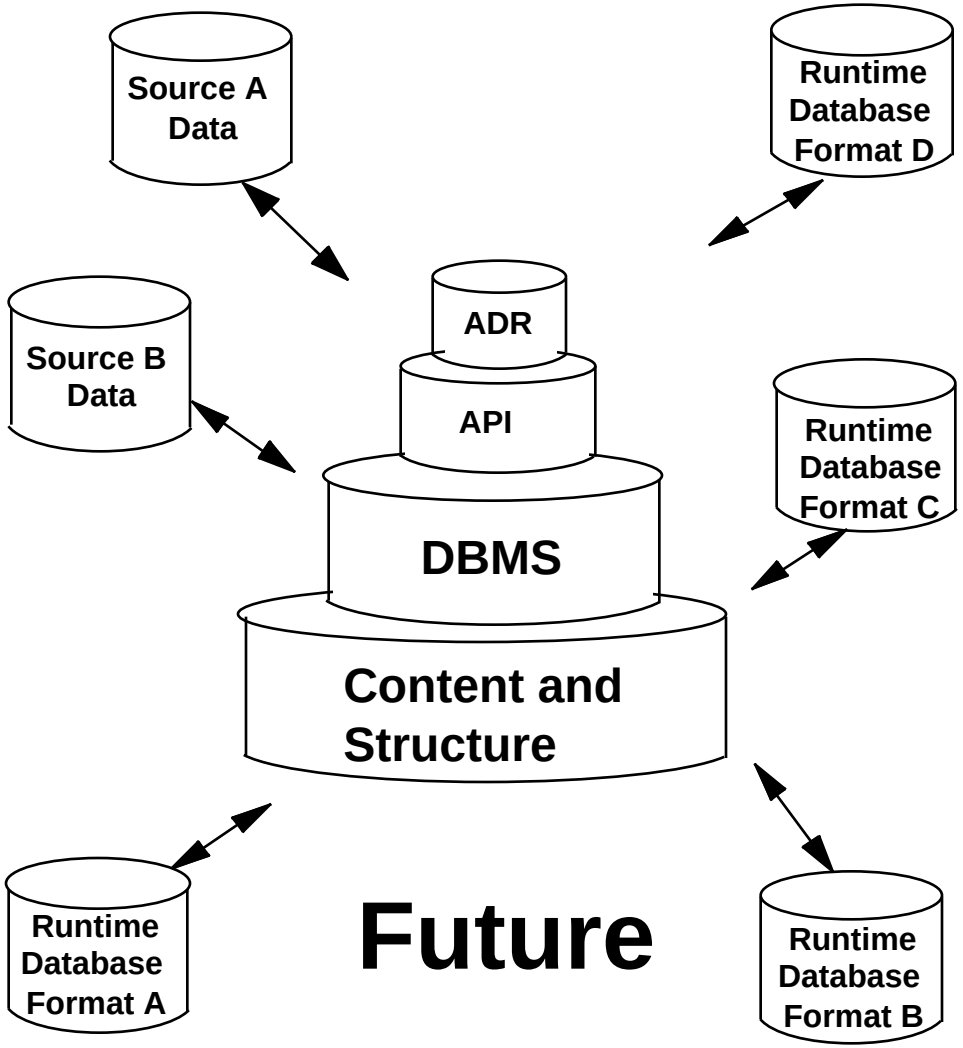
Data Quality

- **Availability, Accuracy, Timeliness, Integrity**
- **VV&A/C Procedures**
- **Tools/Utilities**

Data Interchange Format



Today



Future

Hierarchical Family of DIF Interfaces

Low level, database programmer interface definitions

- **OMG Interface Description Language**
- **ANSI/ISO Structured Query Language**
- **native file formats and DBMS calls where appropriate**

Intermediate level, simulation developer API's

- **OMG Common Object Services**
- **ODBC calls**
- **standard function calls**

High level, simulation end-user Automated Data Retrieval (ADR)

- **OMG Common Object Facilities**
- **HTML/JAVA interfaces to API's**
- **standard end-user windows**

Common Syntax and Semantics

***Semantic Components*:**

- ***Vocabulary***
- ***Sentence***
- ***Context***
- ***Relationship***
- ***Canonical Components***

***Structural Maturity*:**

- ***Internal Knowledge***
- ***Persistent Natural Language***
- ***Fully Structured Views***
- ***Canonical Representations***

Semantics Illustration

Consider similar operations in two different contexts

Army Context

Warfighter Function - Protect Convoy
Common Semantic Reference - ***Defend***

Navy Context

Warfighter Function - Defend BG
Common Semantic Reference - ***Defend***

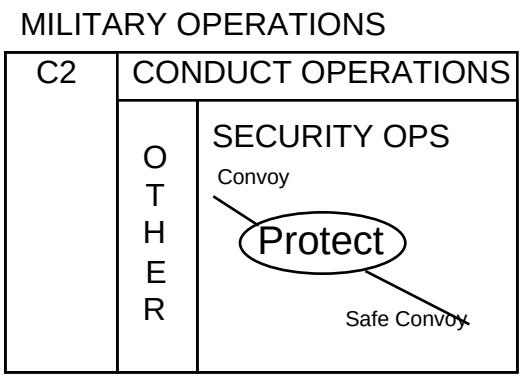
We need to relate "Protect" to "Defend"

- **Establish a common underlying term for reference purposes**
- **Establish a one-to-one correlation between terms and their accepted meanings or "senses"**
- **Call it "Common Semantics**

Syntax Illustration

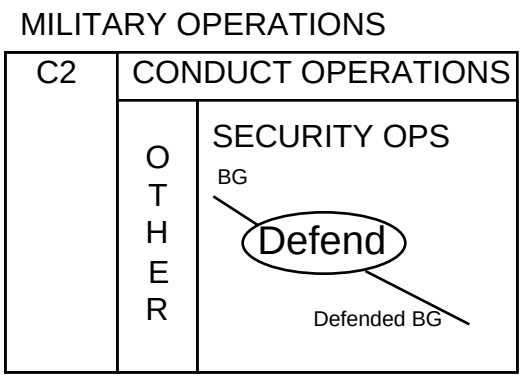
Consider the contexts of the two operations

Army Context



Warfighter Function - Protect Convoy
Warfighting Context - Security Operations
Common Semantic Reference - ***Defend***

Navy Context



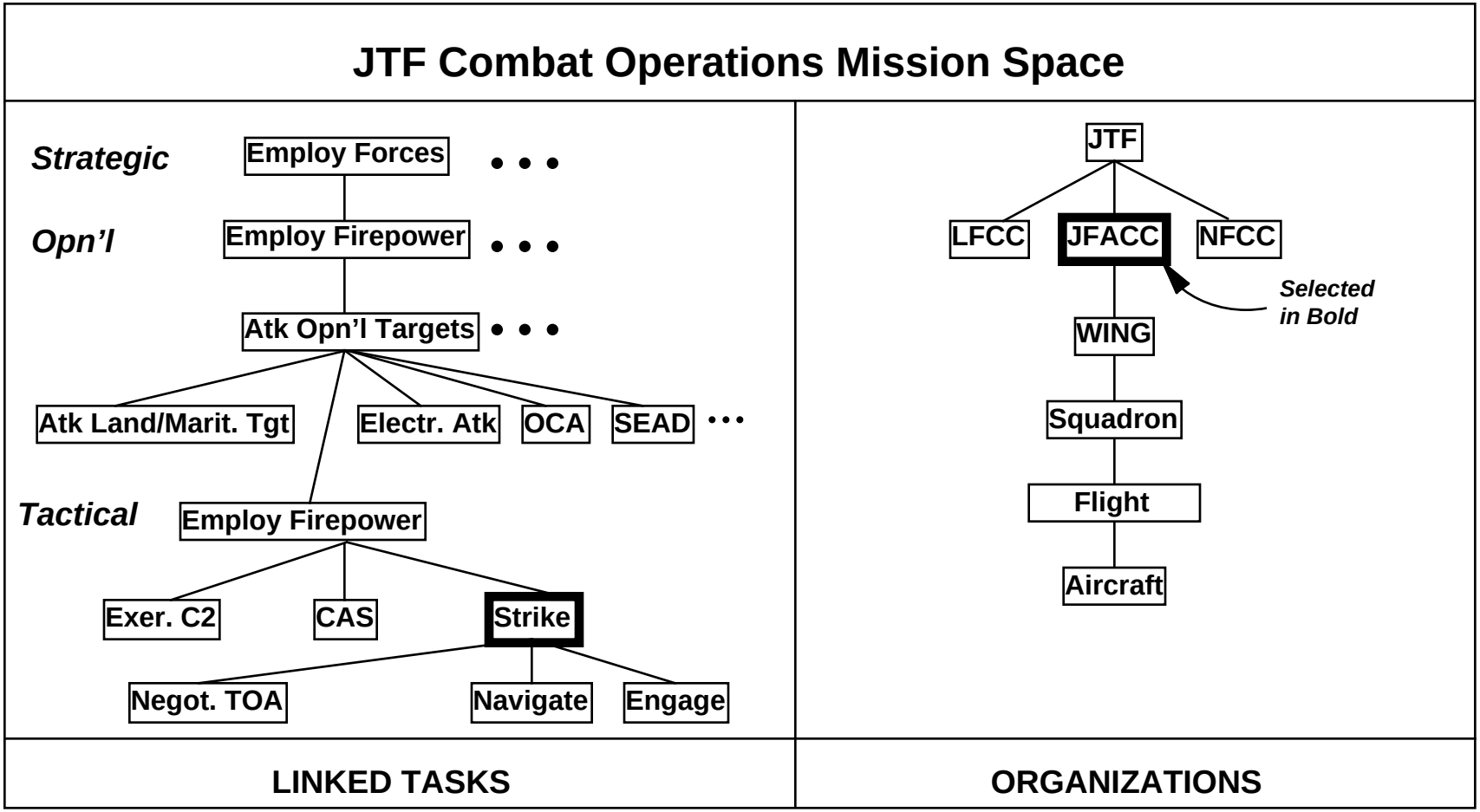
Warfighter Function - Defend BG
Warfighting Context - Security Operations
Common Semantic Reference - ***Defend***

To be meaningful, common semantics must be allowed to differ in different contexts

We need to establish the context for this sense of "Defend"

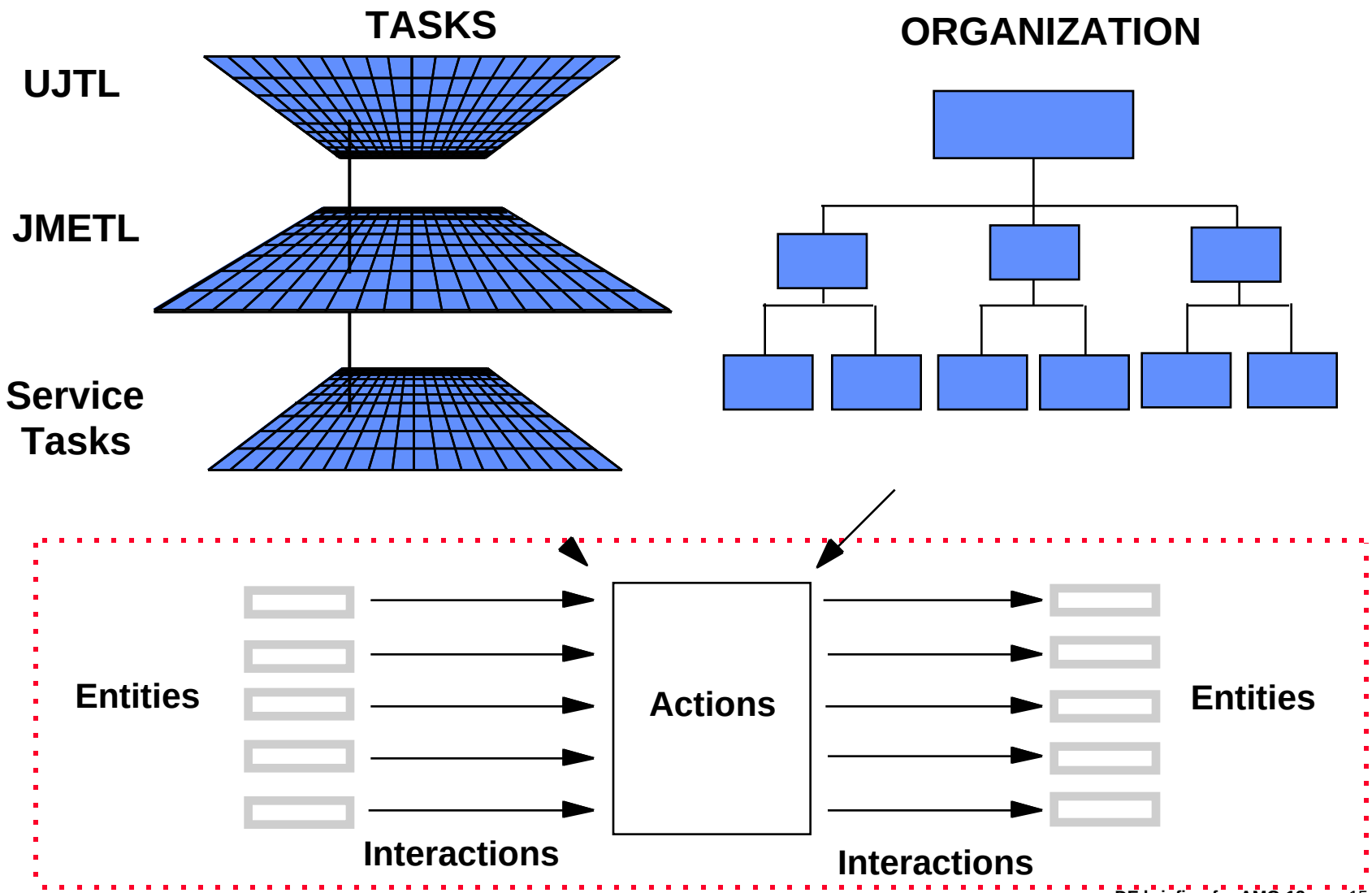
- **Establish a generic syntax or structure of contexts**
- **The common semantic term is valid within one of these contexts**
- **Narrows the field enough to find similarities**
- **Call it "Common Syntax" (where the word may be used)**

CMMS Illustrative Example
Interaction Selection Display



User Selects Interactions Involved in the Strike Task by the JFACC ...

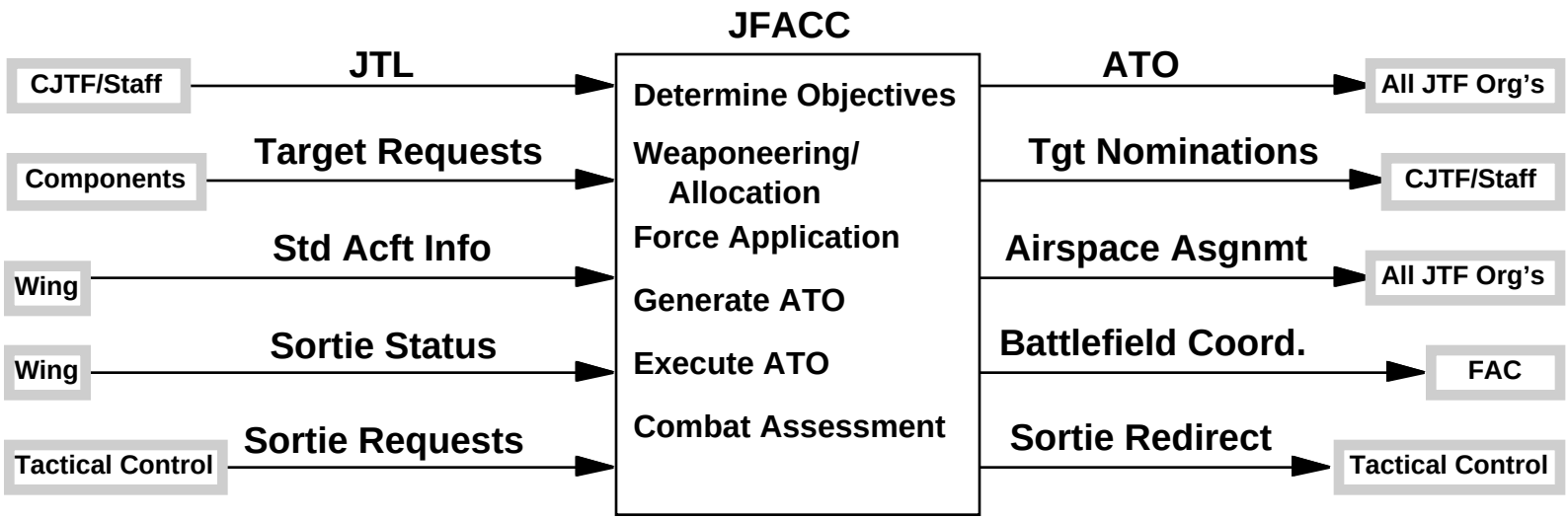
Organizational Concept



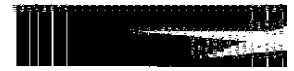
Illustrative Example

Interaction Display

JTF Combat Operations Mission Space



... Display Shows All Actions and Interactions for the Selection, in the Mission Space



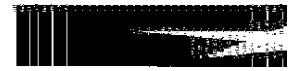
Entities, Actions, Tasks, Interactions: Basic Elements

Entity	**A distinguishable person, place, thing, or concept about which information is kept [2]. In particular, *Entity* includes the notions of person, organization, facility, feature, materiel, and plan defined in [5].**
State	**An *Entity* attribute representing either an internal condition or an external environment.**
Event	**The location in space and time where a change in *State* or condition occurs.**
Action	**The alteration or transformation by natural force or human agency which produces an *Event*, .e.g... move, sense, communicate, engage, or replenish.**

Role	**The function provided by, the part played by, or the character assigned to an *Entity*.**
Actor	**The *Entity Role*-type which takes, executes, conducts, or controls a particular Action.**
Supplier	**The *Entity Role*-type which sends, constructs, or produces the input of a particular Action.**
Receiver	**The *Entity Role*-type which receives or consumes the output of a particular Action.**
Direct-Object	**The *Entity Role*-type which is generated, transformed, or destroyed a particular Action.**
Capability	**The combination of an *Action* and a *Direct-Object* which is recognized as a standard functionality, for example: generate plan, cross river, or shoot missile.**

Entities, Actions, Tasks, Interactions: Smallest Unit of Unambiguous Behavior

Entrance Criteria	**The set of *States* and the sequence of *Events* which are necessary and sufficient to initiate, begin, restart, or continue *Action* by an *Actor*.**
Exit Criteria	**The set of *States* and the sequence of *Events* which are necessary and sufficient to terminate, interrupt, end, or conclude *Action* by an *Actor*.**
Task	**The execution of one or more *Actions* or *Capabilities* by an *Actor*. The *Actor* initiates execution when specific *Entrance Criteria*. During execution the *Action* or *Capability* may receive or consume one or more inputs from *Suppliers*, may produce or deliver to one or more outputs to *Receivers*, and may change one or more *Actor States*. *Task* execution continues until specific *Exit Criteria* are satisfied.**
Interaction	**The interface which defines the flow of *Events*, *State*, *Entities*, or *Tasks* between two *Entities* or *Tasks*.**



Levels of Warfare Abstraction

	Live Operations	Virtual Simulations	Constructive Simulations
Strategic Level	GCCS	NTF-TBMD	ITEM, CBS, AWS, RESA, ...
Operational Level	JMCIS	JMCIS Training Segment	NSS
Tactical Level	ASW Screen, STW Flight	BFTT, WarSim	OpenSAF
Warfigher Level	Tank, Pilot, Sensor Operator	CCTT, ACTS, EW-OBT,	Ordinance Server, IADS, ...
Physical Level	Lift, Drag, Thrust, Sleep Deprivation, Antennae Pattern	Flight Simulator Sonar Stimulator	JMASS,...

DIF Demonstrations

All Require DIF for

- *Authoritative Data Sources* **(ADS)**
- *Authorized Data Consumers* **(ADC)**

CMMS

- **Simulation independent static & dynamic conceptual relationships**
- **Entities, Actions, Tasks, and Interactions (EATI) repository design**

HLA

- **OMT static conceptual relationships between runtime CS objects**
- **OIP dynamic conceptual interactions between runtime CS objects**
- **Protocol catalog FOM/SOM instances.**

Order of Battle

- **Static entities (> things) and their conceptual relationships**
- **Support CMMS design, HLA demonstration, legacy simulations**

SEDRIS

- **Physical “things” and their physical relationships**

MRCI

- **Dynamic conceptual relationships DIF based on COMPASS, CCSIL, DTTM, etc.**
- **Uses each of the CMMS, HLA, OB , and SEDRIS DIF’s at some point in the design, implement, and demonstrate life-cycle**

DIF Development Schedule

DIF	Schedule
•CMMS:	Late summer '96 1st prototype (cycle 1)
•HLA:	
•Obj. Mod. Templ.	ver 1.0 5/96, ver 2.0 10/96, ver 3.0 12/96
•Protocol Catalog	ver 1.0 8/96, ver 2.0 3/97
•SEDRIS	Data model complete 7/96
•Order of Battle	Late summer '96 ver 1.0
•C4I (MRCI)	Plan development 7/96
•Joint Data Fill	Plan development 7/96

Joint Simulation Data Fill

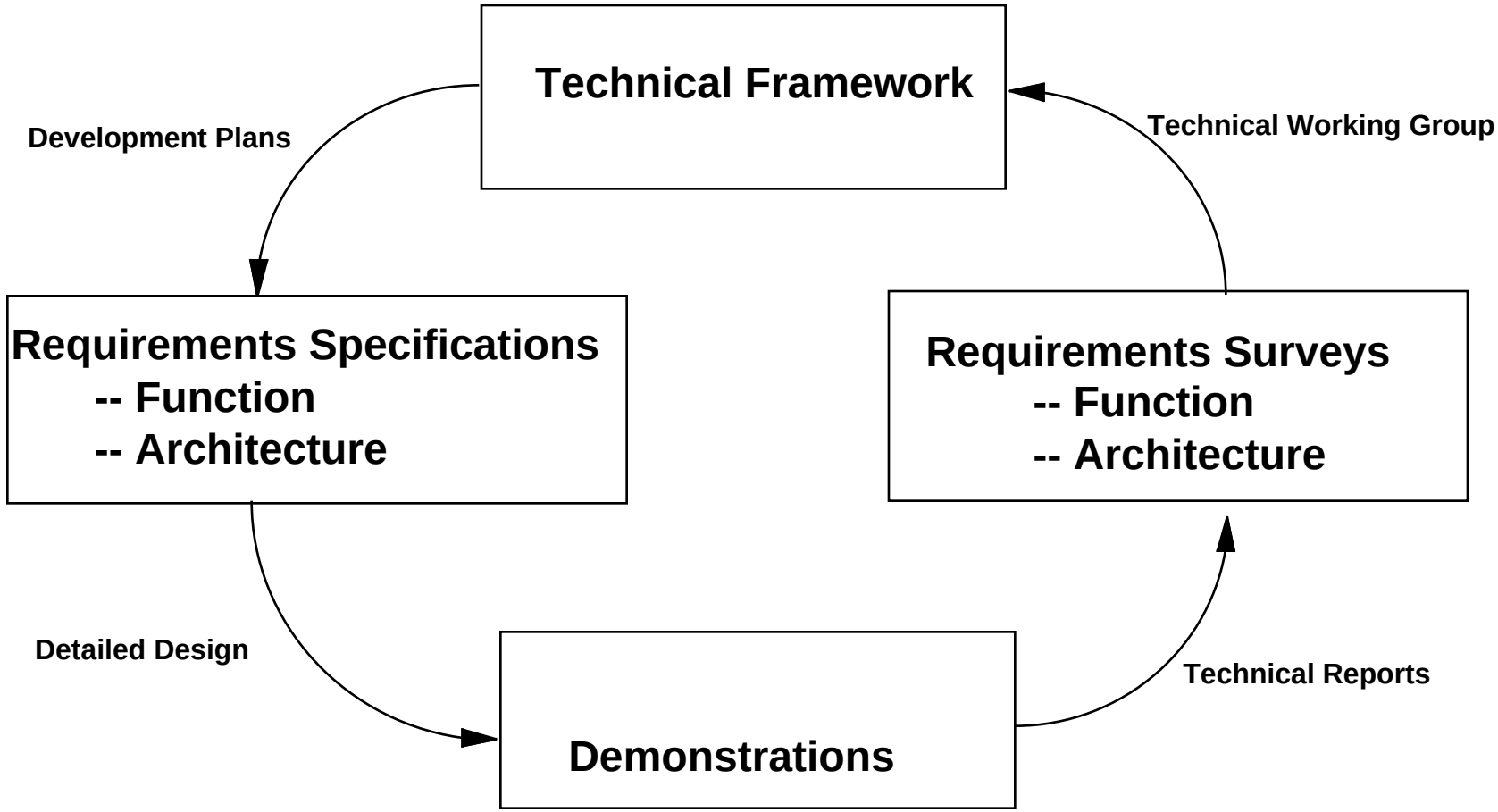
Engage present simulation end-users

- **Maritime: OPNAV N81 representing N6M, SPAWAR**
- **Land: TBD (expect TRAC)**
- **Air: TBD (expect AF XOMT)**

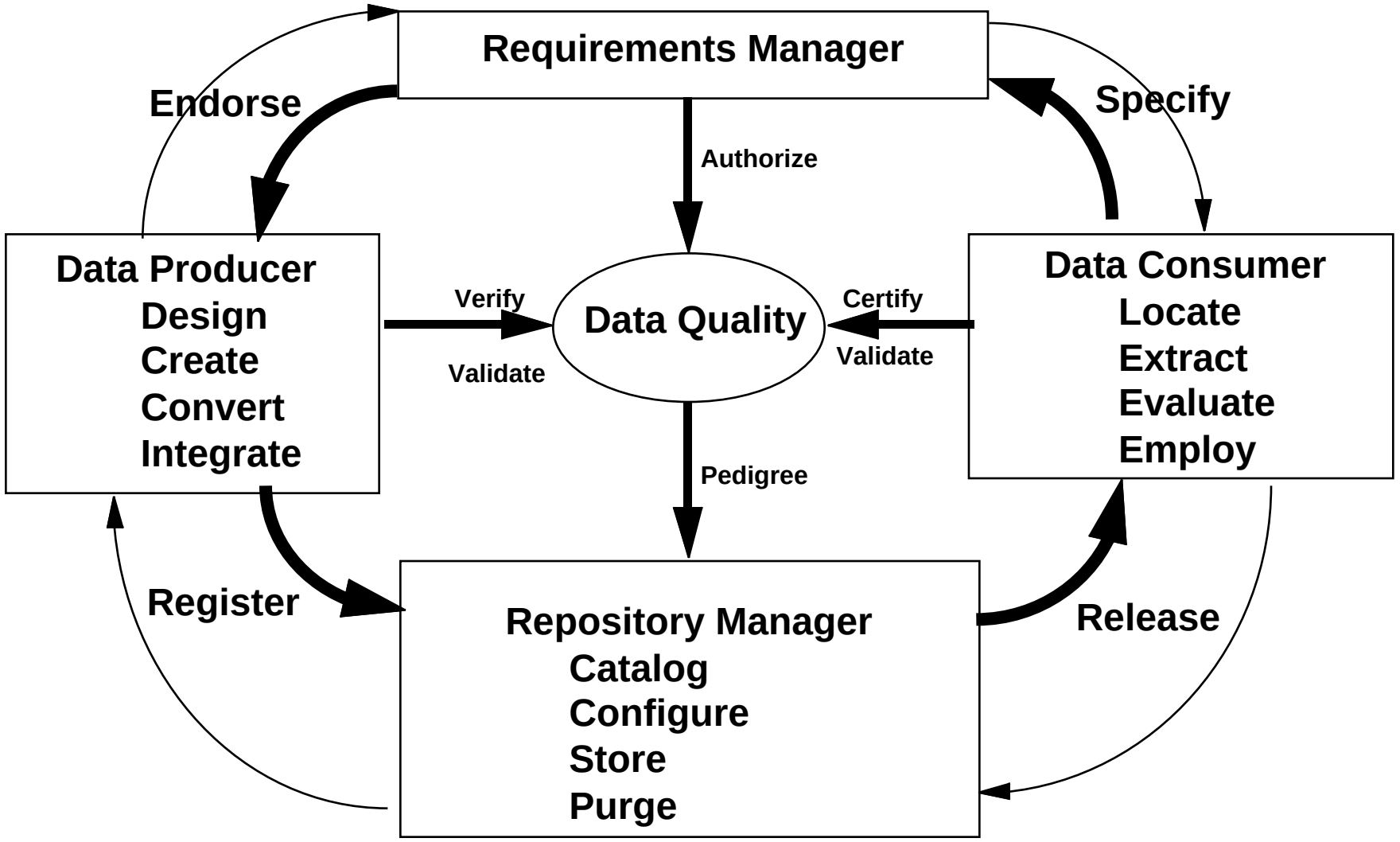
Flagship M&S programs

- **Assessment: JWARS**
- **Training: JSIMS**
- **Acquisition: TBD (JSF ?)**

DMSO Prototype Execution Process: (Two, Interative 6-month Demonstration Cycles)



Data Engineering Process, Version 0.1.3



Supporting DE Products

Data Interchange Formats (DIF)

- **Content (semantics)**
- **Structure (syntax)**
- **Interfaces (tools & utilities)**

Authoritative Data Sources (ADS)

- **Producer Identification**
- **Data Interchange Format**

Authorized Data Consumers (ADC)

- **Consumer Identification**
- **Data Interchange Format**
- **ADS Protection/Releasability**

Data Quality

- **Availability, Accuracy, Timeliness, Integrity**
- **VV&A/C Procedures**
- **Tools/Utilities**

Authoritative Data Sources

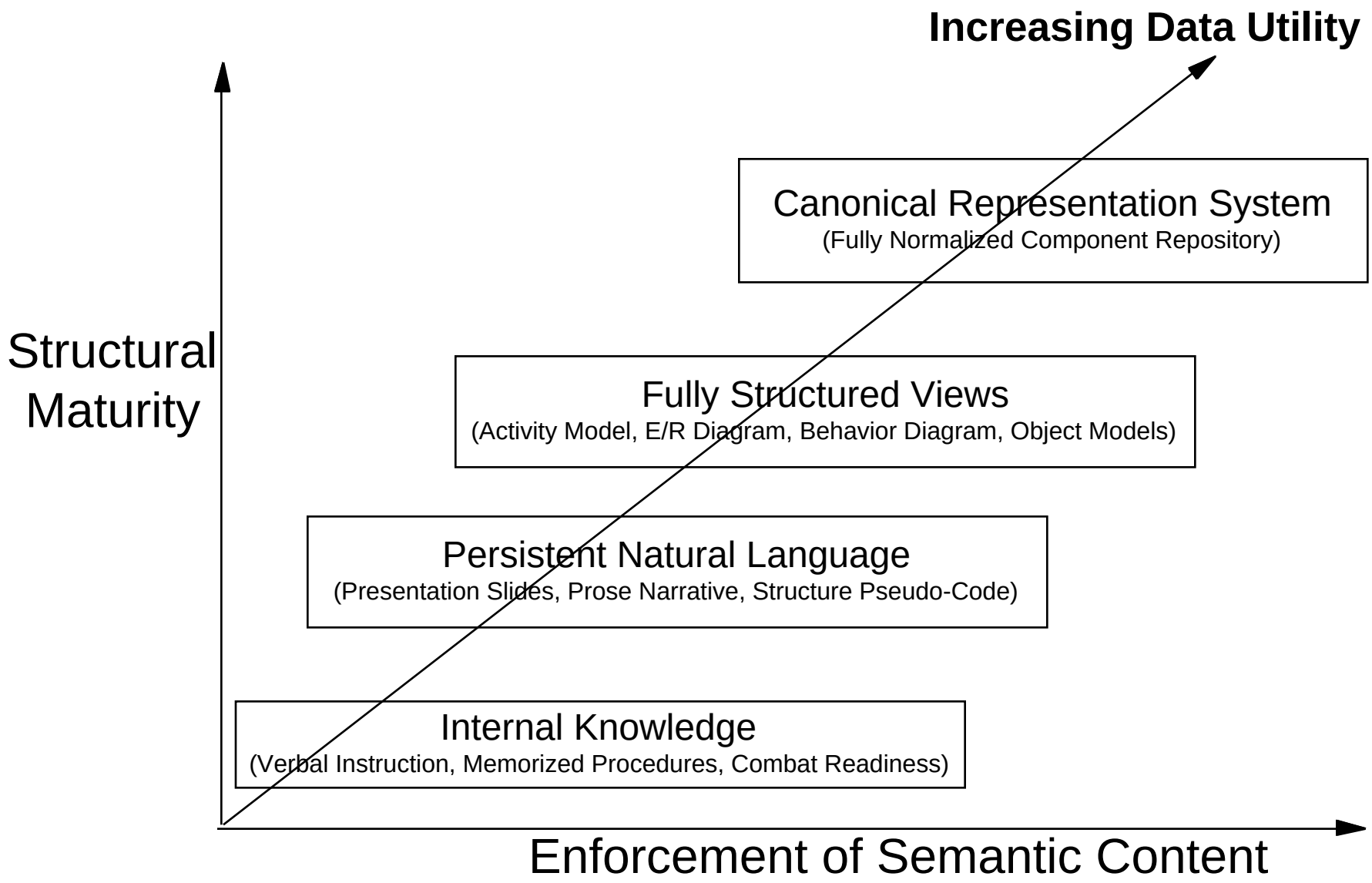
Current Plan

- **M&S priorities for identifying data sources**
  - Complete
- **Define data centers, data sources, authoritative data sources, customers and their responsibilities. Obtain Service approval**
  - Complete
- **ADS database on MSRR**
  - Complete
- **Survey DoD for data sources (in progress)**
  - **Initial visits to Components** **- April 96**
  - **Follow-on visits to identified Service data sources** **- May-Aug 96**
- **Obtain Component Approval of ADS** **- Oct 96**
- **Populate on MSRR with ADS descriptions** **- Oct 96**

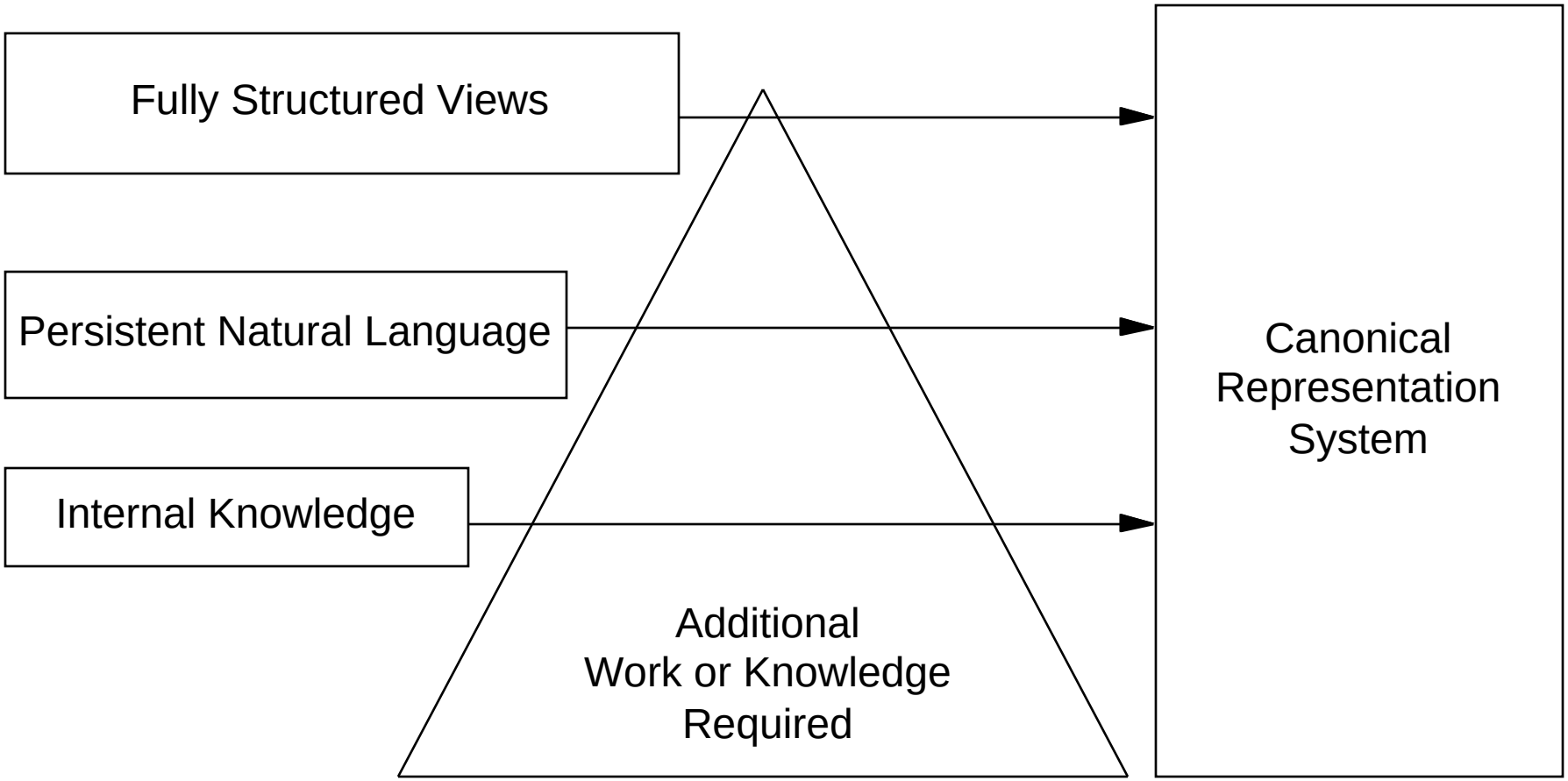
New Initiatives (in progress)

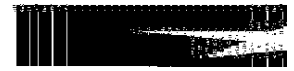
- **Coordinate ADS requirements with Component programs**
- **Extend ADS definitions**

Data Representation Dimensions



Migrating Data at Multiple Levels of Structural Maturity





Authoritative Data Source

***Data Source* is composed of:**

- ***Sponsor***
- ***Producer***
- ***Production Pedigree***
- ***Data* Item or *Model***

***Authoritative Data Sources* is composed of:**

- ***Sponsor***
- ***Examiner***
- ***Data Source***
- ***VV&A/C Pedigree***

Data Source

Sponsor:

The combination of a ***Person***, ***Organization***, and ***Role*** which constitute the ***Actor*** which has been assigned the command responsibility for specific content, structure, or process which are required to create, manage, or release a ***Data*** item or ***Model***.

Producer:

The combination of a ***Person***, ***Organization***, and ***Role*** which constitute the ***Actor*** who, because of either mission or subject matter expertise, actually creates, manufactures, or constructs specific content, structure, or process for incorporation in a ***Data*** item or ***Model***.

Production Pedigree:

The comprehensive audit trail which describes the specific methods and procedures actually employed by the ***Producer*** to create, derive, and construct a particular ***Data*** item or ***Model*** for specified end-use. This pedigree provides ***Data Source*** traceability for constituent ***Data*** items and ***Models*** which were incorporated into or employed to produce the particular ***Data*** item or ***Model*** in question.

Data Source (DS)

The combination of ***Sponsor***, ***Producer***, ***Data***, and ***Production Pedigree*** which provide a ***Data*** item or ***Model***. The ***Producer*** creates the actual ***Data*** item or ***Model*** instance by direction of the ***Sponsor*** and records these activities in the ***Production Pedigree***.

Authorized Data Consumer

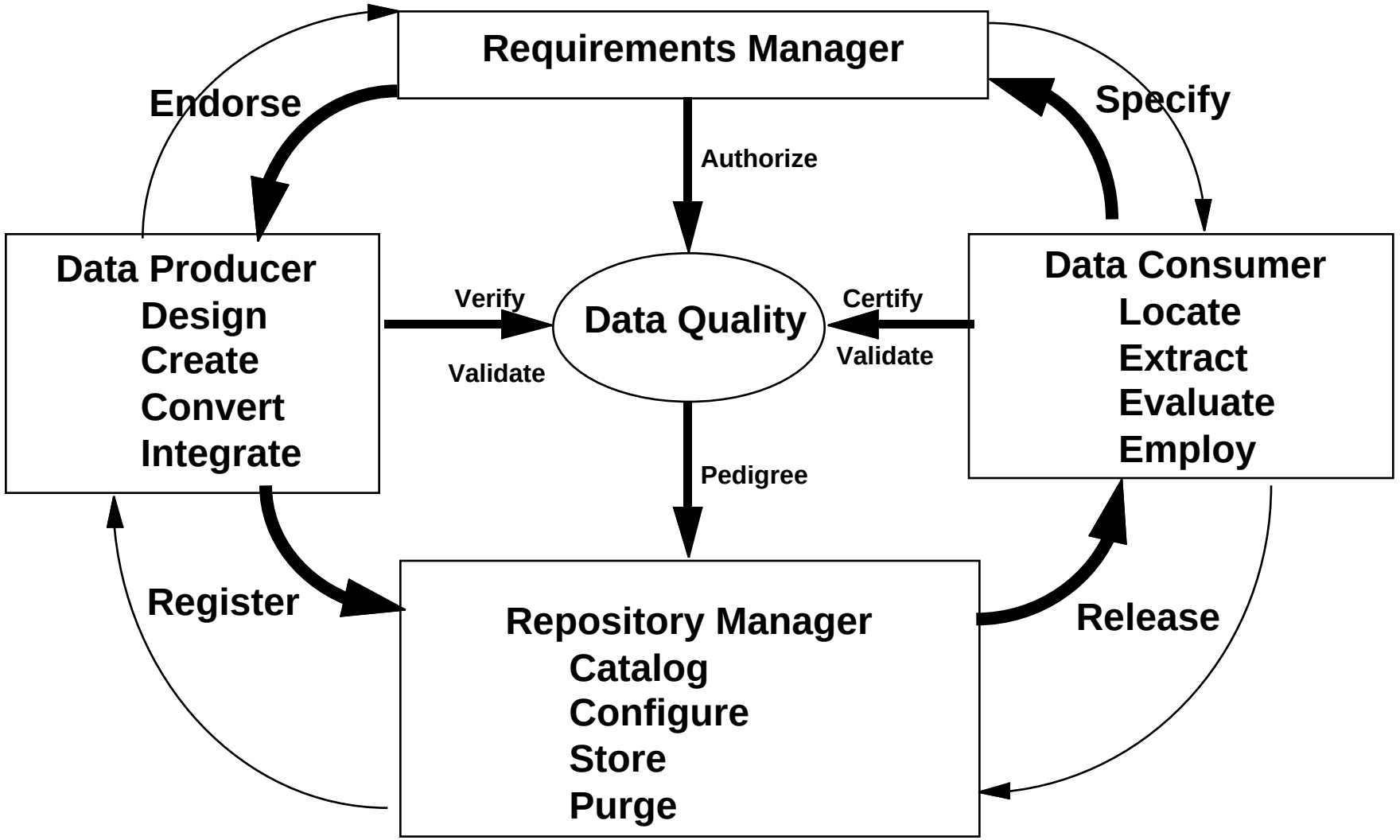
***Data Consumer* is composed of:**

- ***Sponsor***
- ***Consumer***
- ***Clearance***
- ***Security Pedigree***

***Authorized Data Consumer* is Composed of:**

- ***Authoritative Data Source***
- ***Data Consumer***
- ***Access***
- ***Release Pedigree***

Data Engineering Process, Version 0.1.3



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M&S Representations

An M&S representation is the combination of the
1) Model, Process, or Algorithm and the associated
2) Data, Parameters, or Values.

VV&A/C is conducted on the combination of Model and Data in the form of a Representation.

VV&A/C

Verification establishes that the Item produced is what the designer of that Item intended to produce.

Validation establishes that the M&S Item produced accurately reproduces the real world Item that it was designed to represent.

Accreditation establishes that the Model/Process/Algorithm portions of the M&S Item produced is (when used with Certified Data) suitable for a specific end use.

Certifications establishes that the Data/Parameter/Values portions of the M&S Item produced is (when used with an Accredited Model) suitable for a specific end use.

Data Standards Summary: Emulate Success

CMMS/HLA

- **Direct Engagement of M&S Developers**
- **Published Technical Framework**
- **Prototype Execution Process**

Object Management Group

- **Specification + Demonstration = Standard**
- **ORB, Services, Facilitates Framework**

GCCS/JMCIS and NWTDB

- **COE: Faster, Easier, Cheaper to Comply than Deviate**
- **CDS-DIS: Std Elements + Standalone Segment = Reuse**
- **NWTDB: Consumer + Management = Requirement**
  Producer + Management = Repository
  Data Fill